

### REMARKS

Claims 1-10 are pending in the present application and stand rejected. Applicants respectfully request reconsideration of this application in view of the amendments and remarks herein.

Claims 1 and 8 have each been amended to limit the suitable zeolites to those having a ratio of Si:Al of greater than about 5.1. Basis is in the specification at page 2, lines 33-34 and page 3, lines 22-24. Claim 1 was also amended to recite that the sulfur trioxide is in an inert gas carrier. Basis is in the specification at page 4, lines 15-20. Claim 1 was also amended to recite that the sorbent has structural stability and can be stored between sorption and desorption. Basis is in the specification at page 4, line 26 to page 5, line 7; and at page 8, lines 22-24.

#### I. Trademark

The use of the possible trademark "silicalite" without designation as such was objected to. In response Applicants had a trademark search conducted and found that "silicalite" is not a registered trademark in the United States. Thus, the specification has not been amended regarding this term.

#### II. Rejection under 35 USC 112

Claim 1 has been rejected under 35 USC 112, first paragraph, for lack of an enabling disclosure. Claims 1-10 have been rejected under 35 USC 112, second paragraph as indefinite. Applicants respectfully traverse these rejections.

Claim 1 has been rejected for lack of an enabling disclosure in reciting mordenite as a suitable zeolite for use in the claimed invention in that it has a Si:Al ratio of 5:1. Applicants' claimed ratio range was from 1:1 to 4.4:1 and greater than 5.1:1. Thus the ratio of 5:1 for the mordenite disclosed in cited US Patent 5,223,237 is outside of Applicants' claimed range as stated by the Examiner. However, other mordenite compounds are within the claimed range as exemplified in Applicants' Examples 6, 8

and 14 (pages 12, 13 and 15 respectfully) in the specification. Applicants submit that only those mordenites having the Si:Al ratio within the limits specified are intended to be within the bounds of the invention. These claimed limitations are supported in the specification at page 2, lines 33-34  
5 and page 3, lines 22-24. The specification further teaches at page 7, lines 21-29 that preferred sorbents have a Si:Al ratio greater than about 5.1, and most preferred have such a ratio of at least 25, because the materials with lower ratios can become less structurally stable at higher temperatures. Applicants have amended Claim 1 to require the Si:Al ratio  
10 to be greater than 5.1:1 because the structure stability of the sorbent is important to maintaining its activity upon recycling. Applicants therefore submit that Claim 1, as amended herein, is enabled by the specification and meets all requirements of 35 USC 112, first paragraph.

Claims 1-10 were rejected under 35 USC 112, second paragraph  
15 as indefinite. The claimed Si:Al ratios were stated to be unclear. As stated above Applicants' claimed ratio range was from 1:1 to 4.4:1 and greater than 5.1:1. The ratio in each case is equal to the first number divided by 1. Applicants submit that it is common practice to recite ratios to one by simply stating the first number in this manner and this practice is enabling  
20 to those skilled in the art. At no point in the specification was the ratio 5:1 stated, and Applicants respectfully submit that the phrase "greater than about 5.1" is not vague and indefinite.

Claim 2 was stated to be indefinite in use of the terms "provider" and "user". These terms are further explained on page 9, lines 4-11 of the  
25 specification in that the provider is a person who provides a container of sulfur trioxide already sorbed onto a sorbent to a second person who is the user. The user desorbs the sulfur trioxide as needed and then returns the container to the provider. One of the advantages of Applicants' invention is that the user can simply purchase discrete containers of  
30 already-sorbed sulfur trioxide and is relieved of the problems of safe handling of bulk sulfur trioxide. To further prosecution, Applicant has cancelled Claim 2.

Claim 1 is stated to be indefinite in not defining what contains 15% to 100% sulfur trioxide. In response Applicants have amended Claim 1 to recite that the sulfur trioxide feed is in an inert gas.

5 It was stated that none of the claims defined the "provider" and "user" terms and that it was unclear if these were required as part of the sorbent. In response Applicants have cancelled Claim 2. These terms were meant to refer to persons as noted above, and are not part of the sorbent. Thus Applicants submit that use of "consists essentially of" is appropriate in defining the sorbent.

10 In view of the remarks and amendments herein, Applicants respectfully submit that Claims 1 and 3-10 are not vague and indefinite and do particularly point out and distinctly claim the invention in compliance with 35 USC 112 second paragraph.

15 III. Rejection under 35 USC 103

Claims 1-10 were rejected under 35 USC 103 as unpatentable over US Patent 5,223,237 of Simpson et al. in view of the reference titled 'Study of Absorption of Sulfur Trioxide by Zeolites' by Anurov et al. Applicants respectfully traverse this rejection.

20 The Simpson et al. patent was cited as teaching an obvious variation of the claimed process and Anurov et al. was cited as disclosing sorption and desorption within the claimed temperature range. Thus Applicants' invention was considered obvious.

25 Applicants' invention is directed to reversible sorption of sulfur trioxide while maintaining high activity of the sorbent. To obtain this continued high activity requires avoiding structural degradation of the sorbent. Structural degradation of the sorbent results in a loss of sorption capacity for sulfur trioxide.

30 Applicants' claims require anhydrous conditions specifically to avoid structural degradation of the sorbent. When water is present sulfuric acid is formed which degrades the sorbent. Simpson et al. teach use of water to purge the sorbed sulfur oxides, thus displacing the sulfur oxides with water. See column 6, lines 21-32. Thus, Simpson et al. teach conditions

that result in degradation of the sorbent. The only teaching by Simpson et al. relating to preventing reduction in bed sorption capacity is to minimize the sulfur oxide residence time on the sorbent (Column 9, lines 56-61). In contrast Applicants' invention permits an extended residence time while  
5 maintaining the structural integrity of the sorbent, and thus maintains its high reactivity in repeated cycles. This permits the sulfur trioxide to be sorbed onto the sorbent at one location, transport of it in a container to a second location, followed by desorption of the sulfur trioxide at the second location. Thus the user who needs sulfur trioxide in a particular operation  
10 does not have to be equipped for the safe handling of bulk quantities of sulfur trioxide, but instead can purchase discrete canisters of it in the quantity desired. Simpson et al. do not teach or suggest that use of anhydrous conditions is desirable. Simpson et al. in fact teach that use of a water purge is superior to achieve a brief desorption period (Column 9,  
15 lines 1-8). Simpson et al. do not teach any means to avoid reduction of the sorption capacity of the sorbent other than short residence time of sulfur oxides on the sorbent. This is directly contrary to the purpose of Applicants' invention. See page 8, lines 22-24 and page 9, lines 4-11 of the specification. Thus Applicants maintain that the claimed invention is  
20 not obvious over Simpson et al.

Anurov was cited as teaching that zeolites can sorb sulfur trioxide out of a gas at certain temperatures. In Figure 3 Anurov et al. depict a graph that shows that the adsorbent activity decreases with the number of cycles. This is attributed to the formation of aluminum sulfate which  
25 dealuminizes the zeolites, and leads to destruction of their crystal lattice and the resultant decrease in adsorptive capacity. In comparison, Applicants' Figure 1 shows no deterioration of the sorbent molecular structure over ten cycles when the process of the claimed invention is employed. Anurov et al. does not teach or suggest a process to preserve  
30 such sorbent activity. Thus, Applicants maintain that Anurov et al. does not teach or suggest the claimed invention.

Further, combining Anurov et al. with Simpson et al. does not teach or suggest the claimed invention. Neither contains any examples of

sorption of sulfur trioxide alone, but demonstrate sorption and desorption of mixtures with other oxides. Sulfur dioxide is a weak Lewis acid, while sulfur trioxide is a strong Lewis acid. A Lewis acid is an electron pair acceptor. A strong Lewis acid, such as sulfur trioxide, would be expected to strongly adhere to the sorbent. Thus teaching a process for sorption and desorption of sulfur dioxide, or its mixture with sulfur trioxides does not suggest an effective process for sorption and desorption of sulfur trioxide alone, especially desorption. One skilled in the art would expect sulfur trioxide to sorb strongly and irreversibly to the sorbent due to its strong Lewis acid character. Neither Simpson et al. nor Anurov et al. addresses this issue. Thus Applicants' invention provides unexpected results not suggested by the cited art. Applicants therefore maintain that Claims 1 and 3-10 are not obvious under 35 USC 103 over Simpson et al. or Anurov et al. singly or combined.

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#### IV. Conclusions

In view of the amendments and remarks herein, Applicants respectfully maintain that Claims 1 and 3-10 are patentable over the cited art, and respectfully request that a patent be issued on these claims. Should any questions arise, the Examiner is invited to contact Applicant's attorney at the number noted below.

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Respectfully submitted,



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**VERSION WITH MARKINGS TO SHOW CHANGES MADE**

5 In showing the changes, deleted material is shown as bracketed,  
and inserted material is shown as underlined.

**IN THE CLAIMS:**

10 1. (Amended) A process for reversible sorption of sulfur  
trioxide onto a sorbent comprising a) contacting from about 15% to 100%  
sulfur trioxide in an inert gas with the sorbent under anhydrous conditions  
at a temperature of from about 35°C to about 150°C thereby sorbing the  
sulfur trioxide onto the sorbent which sorbent is then capable of storage,  
15 b) desorbing sulfur trioxide from the sorbent at a temperature of from  
about 150°C to about 350°C at about atmospheric pressure, or under a  
vacuum pressure, and c) recycling said sorbent by continuously repeating  
steps a) and b), wherein said sorbent has structural stability upon recycle,  
a pore size of at least 0.5 nm, and consists essentially of silica or zeolite,  
20 said zeolite having a silicon to aluminum ratio [in the ranges of from about  
1 to about 4.4 or] greater than about 5.1.

Cancel Claim 2. [2. The process of Claim 1 wherein a provider  
sorbs the sulfur trioxide onto the sorbent and provides it to a user, and the  
user desorbs the sulfur trioxide and recycles the sorbent to the provider.]

25 3. The process of Claim 1 wherein the sulfur trioxide sorbed  
and desorbed is of purity of from about 99% to 100%.

4. The process of Claim 3 wherein the sulfur trioxide is of a  
purity of at least 99.9%.

30 5. The process of Claim 1 wherein the sorbent has sorbed  
thereon from about 3% to about 60% by weight sulfur trioxide.

6. The process of Claim 1 wherein the sulfur trioxide is sorbed  
onto the sorbent at a temperature of from about 50°C to about 125°C.

7. The process of Claim 1 wherein the sorbent is a silicalite or a  
zeolite having a silicon to aluminum ratio of at least 25.

8. (Amended), A sorbent consisting essentially of silica or zeolite, said zeolite having a silicon to aluminum ratio [in the ranges of from about 1 to about 4.4 or] greater than about 5.1, said sorbent having a pore size of at least 0.5 nm, and having adsorbed thereon a minimum of about 1% by weight sulfur trioxide.

9. The sorbent of Claim 8 having a silicon to aluminum ratio of at least 25.

10. The sorbent of Claim 8 in a pelletized, beaded or chopped form.